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Professional development in data use

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Chapter 1

General introduction

1.1 Introduction

Given the importance of math competence for students' future performance (Aubrey, Dahl, & Godfrey, 2006; Claessens, Duncan, & Engel, 2009; Bodovski & Youn, 2011), concerns about the level of mathematics proficiency of Dutch students can be considered relevant. According to results of international studies, like TIMSS (Meelissen & Drent, 2008; Meelissen et al., 2012), Dutch students can be considered well performing. Yet some slight but significant decreases have been found when comparing students' current math skills to those around the turn of the century (Meelissen & Drent, 2008; Royal Netherlands Academy of Arts and Sciences, 2009; Scheltens, Hemker, & Vermeulen, 2013). Moreover, in TIMSS 2011, the Netherlands was one of the few countries that showed decreasing performance in the period 2001-2011 (Meelissen et al., 2012). The low spread in the math proficiency levels further indicates that, although the number of very weak students is relatively low, the same is true for the number of excellent performers. It can therefore be questioned whether the mathematical competence of all students, and specifically of the high performers, is fostered optimally.

These concerns prompted the launch of a quality agenda ("Scholen voor morgen", Dijkema, 2009) and action plans ("Basis voor presteren", Ministry of Education, 2011) by the Dutch Ministry of Education supporting primary schools in improving students' basic skill proficiencies. These initiatives are, among other things, focused on the use of data for improving education and educational outcomes, as is the case in educational policy in many western countries (Carlson, Borman, & Robinson, 2011; Downey & Kelly, 2013; Dunn, Jaafar, Earl, & Katz, 2013; Lai, McNaughton, Amituanai-Toloa, Turner, & Hsiao, 2009; Schildkamp, Karbautzki, & Vanhoof, 2014).

The general tendency is that teachers should become data-literate, as their current level seems to be insufficient. There seems to be a need for improving teachers' knowledge and skills in both interpreting data-analyses as well as translating them to instructional changes that suit students' needs (Goertz, Oláh, & Riggan, 2009; Mandinach, 2012). This dissertation concerns the evaluation of a teacher professional development program in which teachers' "pedagogical data-literacy" (Mandinach, 2012) is fostered. Teachers' pedagogical data-literacy can be understood as their ability to monitor data, use the information provided by these data to meaningfully inform their instructional decisions, and act upon these decisions in class. The dissertation's central research question is: *To what extent can a professional development program on data use, containing the three interrelated, evidence-informed components performance*

goals, data-analysis *and* instruction, *enhance teacher change and, as a result, students' mathematical achievement?*

This general introduction first discusses the concept of data use and teachers' current use of information for educational improvement. Next, main findings on the effectiveness of professional development initiatives are discussed. Thereafter, the four empirical studies that were conducted in order to answer the main research question are briefly described, thereby making clear how they related to each other and what emphasis we wanted to place while studying teachers' data use.

1.1.1 Data use

In the literature, two main conceptualizations of data use, or data-driven decision making (DDDM), are in use.¹ The first conceptualization focuses on the use of data for accountability purposes. Especially in the United States, schools and teachers are held accountable for their educational outcomes; the educational quality of schools and teachers is judged based on such measurable outcomes. Should this quality, as measured by the data, be insufficient according to specific standards, schools tend to get sanctioned (Hellrung & Hartig, 2013; Linn, 2003). Such accountability pressures are also found in the Netherlands, although their consequences seem to be less severe. The Dutch Educational Inspectorate promotes a dual use of data, both to account for educational outcomes and for school improvement purposes (Ehren & Swanborn, 2012). The latter, using data for instructional improvement, reflects a second conceptualization that is found in the literature. In this view, data are collected, analyzed and used in order to improve future teaching; in other words, data are used in a formative way to better fit teaching to the students' actual instructional needs. Such a formative use of data is reflected in Schildkamp and Kuiper's definition of data use as "systematically analyzing existing data sources within the school, applying outcomes of analyses to innovate teaching, curricula, and school performance, and implementing (...) and evaluating these innovations" (Schildkamp & Kuiper, 2010, p. 482). In this view, data are expected to facilitate schools and teachers to implement well-founded educational and instructional decisions that are more aligned to what students really need. Such a better fit of teaching practice to actual needs is expected to not only improve teaching, but, as a result, to

¹ Note that in this dissertation the terms data use and data-driven decision making are used to denote the same concept. The terms are used interchangeably.

improve student performance as well. Improved student outcomes are a central aim of DDDM.

In order to use data effectively and to deliberately base decisions on data, teachers, but also school principals and senior support coordinators, should be (pedagogical) data literate. Up to date, national and international studies have shown that teachers experience problems when using data (Goertz et al., 2009; Hellrung & Hartig, 2013; Hubbard, Datnow, & Pruyne, 2014; Mandinach, 2012; Staman, Visscher, & Luyten, 2014; van der Kleij & Eggen, 2013; Wayman & Jimerson, 2014). In the Netherlands, for instance, teachers have been found to struggle with adequately interpreting analyses from the student monitoring system - the “Cito-system” - (van der Kleij & Eggen, 2013), to have a tendency to not use explicit goals for determining their students’ desired proficiency levels (Educational Inspectorate, 2010; Schildkamp, Vanhoof, van Petegem, & Visscher, 2012), and they do not take the different student needs adequately into account (Educational Inspectorate, 2010; 2013; 2014): A considerable amount of primary school teachers differentiates in their math lessons in terms of task-difficulty and within-class grouping, but modifying their *instruction* to suit the different student needs is found to a lesser extent. Moreover, it has been questioned whether teachers use information on students’ proficiency in adapting their instruction (Harskamp, 2010; Educational Inspectorate, 2010).

Given the concerns on the Dutch students’ math proficiency level and the insufficient level of data use by Dutch teachers and school teams, professionalization of the school teams and teachers is called for. More specifically, teachers are the ones who have to translate the information coming from the data into meaningful instructional actions. Hence, targeting teachers for professional development initiatives seems to be promising.

1.1.2 Professional development

Desimone (2009) modeled how professionalization is expected to influence teachers, teaching practice, and student outcomes in her framework for professional development (PD - Figure 1). The idea is that, in an ideal situation, the new knowledge and/or practical skills provided by the PD foster teacher learning, resulting in increased teacher knowledge and skills, and in changed attitudes, improved teaching practice and, as a result, increased student performance. In developing and carrying out professional development programs (PDPs), it is considered important that they adhere to the five critical or core features for which consensus is found in the field of PD-research

(Desimone, 2009). High quality PD focuses on (domain specific) content, contains active or inquiry-based learning, is coherent with educational policy, takes sufficient time, and enables participants to collaborate with each other. Timperley, Wilson, Barrar, and Fung (2007) added, based on their best-evidence synthesis, additional PD-features that were found to be related to better student outcomes: the use of external expertise, a focus on really engaging teachers in the learning process, and an overt discussion of issues that disagree with teachers' prior knowledge and beliefs. Some authors (e.g., Desimone, 2009; Guskey, 2009; Hochberg & Desimone, 2010; Timperley & Parr, 2009; Wayne, Yoon, Zhu, Cronen, & Garet, 2008) also emphasized the importance of the context (e.g., student and teacher characteristics, school organization, and environment). These contextual characteristics could function as mediating and moderating factors for teacher learning, and thus influence implementation to a considerable extent.

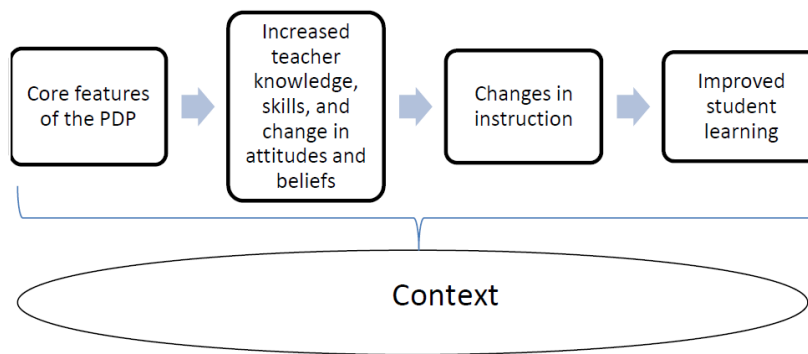


Figure 1: Desimone's core framework for studying the effects of PD on teachers and students (Desimone, 2009, p. 185)

In its early days, PD research mainly focused on investigating teachers' self-reported satisfaction and changes in attitudes, but this emphasis on teachers' experiences shifted to studying the impact of PDs on teacher behavior and student performance in recent years (cf. Desimone, 2009; Hill, Beisiegel, & Jacob, 2013). Yoon, Duncan, Lee, Scarloss, and Shapley (2007) showed in his review on effective PDs that few rigorous studies investigated PD impact on student achievement. Borko (2004) also addressed this need for more knowledge on effective PDs. According to Borko, most PD research concentrates on the effects of a sole PD program, conducted by one facilitator at one site, making it difficult to generalize study findings (phase 1). Therefore, PD research should focus more on investigating program effects in phase 2-studies, in which one PD program is carried out by several facilitators at more than one site, but also in phase 3-studies, that compare the effectiveness of different PD programs at different sites. Although many

scholars have recently stressed the need for such more rigorous large-scale studies (Borko, 2004; Wayne et al., 2008; Yoon et al., 2007; Hill et al., 2013), phase 1 studies should be valued in their role of providing existence proof of a program (Borko, 2004; Guskey & Yoon, 2009). Such existence proof can be considered a crucial phase, a necessary step in the process of scaling up PDPs.

The lack of finding sustainable evidence for program effectiveness in some recent large-scale innovations² showed the relevance of only scaling up PDPs whose provisional effectiveness has been proven in smaller, rigorously designed studies. The aim of this dissertation is to investigate the effectiveness of a PDP on data use in terms of its impact on teacher attitudes, teaching practice and students' mathematics achievement. The study relates to one PDP, conducted at different sites, designed and carried out by the researchers. Since data use is one of the spearheads of educational policy in many countries of the Western industrialized world, investigating the effectiveness of such a relatively small-scale, carefully controlled study is justified (Guskey & Yoon, 2009).

1.2 The current project

A PDP was carried out to professionalize teachers in their use of data for instructional improvement purposes. Data offer teachers feedback on the effectiveness of their teaching practices for students' performance, based on which teachers can enhance their practices. Data use can be considered to consist of three core features (Hattie & Timperley, 2007; Ramaprasad, 1983; Visscher & Ehren, 2011): a. determining the desired level, b. establishing the actual level, and c. modifying the instructional practices to close the gap between the desired and the actual level. In developing our PDP, we operationalized these core features in three interrelated components, for which empirical evidence was found that they were related to better student achievement (Fuchs, Fuchs, & Deno, 1985; Locke & Latham, 2002; Lai et al., 2009; Carlson et al., 2011; Slavin, Cheung, Holmes, Madden, & Chamberlain, 2013; Borman, Hewes, Overman, & Brown, 2003; d'Agostino, 2000; Van Gog, 2013). For determining the desired level of student proficiency (feature a), teachers were asked to set performance standards and performance goals. Feature b, determining the actual level, was operationalized by learning teachers how to use simple and more complex analyses in the digital student monitoring system in order to analyze and interpret the math development of their own

² Hill et al. (2013) mention in this respect the studies of, e.g., Bos et al., 2012; Garet et al., 2011; Santagata, Kersting, Givvin, & Stigler, 2010.

students. Further, teachers were introduced to and conducted diagnostic math interviews through which they could learn more about students' mathematical understanding. An instructional component, facilitating the modification of instruction (feature c), focused mainly on two effective instructional methods, *direct instruction* and *modeling*, supplemented with math-specific recommendations, like the provision of explicit instruction in approaching word problems.

The year-long PDP targeted both mathematics and reading comprehension in a joint program. The program content for both subject domains was mainly the same (setting performance standards and goals for both math and reading, analyzing student data for both students' math and reading proficiency, and promoting the two general instructional methods for both subject domains), but deviated in the subject-specific instructional part. For reading this part focused on the curriculum and instruction, for math on more complex and elaborate data-analyses (like the diagnostic math interview) and instruction. For an elaborate description of the program and the data-analyses offered, the interested reader is referred to the Appendices at the end of the dissertation.

Our PDP consisted of 9 meetings and targeted school principals, senior support coordinators, and teachers of grades 2 and 3. These participants formed small professional learning communities, collaborating on the three PD components. Given the attention that was paid to content, the active hands-on inquiry-learning, its coherence with national educational policy, its time span (one year) and number of hours (teachers were supposed to spend approximately 40 hours on the PDP), and the central role of professional learning communities in it, the PDP was assumed to adhere to the core features of effective PD initiatives (Desimone, 2009). Further, the researchers brought in external expertise on educational effectiveness and data use, and the job-embeddedness of the PDP was assumed to promote commitment of the teachers (Timperley et al., 2007). Moreover, the PDP was supposed to consist of several elements that were found to be facilitators for data use: making teachers sufficiently knowledgeable in using the technology needed, offering sufficient time to use data (the meetings focused on discussing the data of the students in school), and promoting active participation and contributions of the principal, if applicable (Schildkamp & Kuiper, 2010). Given its content and set-up, the PDP was expected to foster teacher change, thereby positively affecting teaching practice and student achievement.

1.3 Overview of the dissertation

The main purpose of the current study was to investigate whether a year-long PDP on data use, delivered in an ecologically valid context, would be able to bring about positive changes in teacher attitudes, teaching practice, and students' mathematical achievement. Its potential in a realistic setting was a premise for our study: we wanted to know whether we could professionalize teachers in such a way that it would lead to changes in teaching behavior and student outcomes in daily practice. After all, it is in realistic settings that the program is supposed to influence participants. Moreover, the current policy focus on data use already forces schools to act on data, leaving no room for delays in learning all teachers to effectively use data.

Originally, the most important aim of our study was to investigate the distal outcomes of the PDP, relating teachers' participation in the PDP to students' math achievement. However, without information on the proximal outcomes (teacher attitudes and behavior) interpretation of these distal outcomes, and thus understanding whether and how our PDP worked, would be difficult (Wayne et al., 2008). A second focus was therefore on studying the attitudes and behavior of teachers who participated in the PDP. This would allow us to study whether potential changes in math achievement could be understood in terms of changes in teacher beliefs and teaching practice, as was assumed by Desimone's theory of action (see Figure 1). For this purpose, teachers' implementation of the program content was studied, using both the information from high-inference math lesson observations and from a teacher questionnaire. We further wanted to gain better understanding in what actually happened in class by looking at the naturally occurring differentiation practices, as differentiation is assumed to be a direct consequence of data use. By using a low-inference observation instrument we investigated (preconditions for) differentiation and the ways in which teachers varied instructional support toward different types of students. By focusing on teacher attitudes and behavior, and teaching practices we attempted to embed findings on student outcomes in terms of how the PDP might have had an impact on the teachers.

1.3.1 The empirical studies

In chapter 2, the relationship between performance goals, teacher ambition, and students' math achievement is discussed. Studying the goals in more detail was motivated by their essential role in DDDM: setting explicit goals for students assumes teacher awareness of what the desired level of student proficiency is and subsequent monitoring of student performance can be done in light of these goals. In organizational

and educational studies, goal setting has been positively associated with (student) performance (Fuchs et al., 1985; Fuchs, Fuchs, & Hamlett, 1989; Locke & Latham, 2002). Educational effectiveness studies further showed that high teacher expectations, reflected in challenging goals, positively affect student achievement (Scheerens & Bosker, 1997). As such, a positive relationship between performance goals and student achievement was one of the premises of our PDP and given their central role in the PDP, empirical evidence for this assumed connection was sought. Next, it was investigated whether and in what direction, a step-by-step procedure, in which teachers' original expectations were contrasted to data and team input, led to changes in the height of the teacher-set goals. In cases where the step-by-step procedure led to higher final goals than the original expectations, these deviations from the initial expectation were called positive changes. Such positive changes were considered to reflect minimized negative expectation bias or maybe even positive expectation bias. It was investigated whether such positive changes related to students' math achievement. Using propensity score matching two comparable groups of students were matched: those for whom teachers became more ambitious (the positive change group) and those for whom the teachers had set the same original and final goals. Outcome analyses were carried out using multilevel analyses.

If teachers determine the desired proficiency levels for each student in class and relate such goals to data on students' current proficiency levels, then differences between the students in class and their varying needs immediately become apparent. Taking such differences into account could result in the use of differentiation practices. Teacher variability in differentiation practices is studied in chapter 3. Here, low-inference observations of both the math and reading comprehension lessons of the trained teachers provided information on preconditions for differentiation and classroom organization, including the provision of extended instruction to small groups of students. It was further investigated to what extent contextual features related to the differentiation practices used by the teachers. In order to better understand how students of different math performance levels were addressed by their teachers, we also studied students' setting and the amount and nature of the teacher talk to individual students in more detail. For this purpose, we selected four different students in each class, based on their math proficiency level (the very weak, weak, average, and advanced students).

Chapter 4 focuses on the effect of the PDP on students' mathematical achievement. Given the quasi-experimental design of the study, we tried to minimize selection bias by using Propensity Score Matching for yielding two groups of students that were comparable on several characteristics, except for whether they were taught by a

teacher who participated in the PDP or not. Two matching procedures took place. The first procedure, in which the full sample was used, matched students based on student and class characteristics. Next, as a robustness check, a second procedure was carried out in which the remaining selection bias was further reduced by also taking teacher characteristics into account. For investigating whether being taught by a teacher who participated in our PDP related to students' math achievement, multilevel analyses were used.

In the fifth chapter levels of implementation of the PDP are studied in order to better understand the distal outcomes. First, we investigated in an explorative way whether the attitudes and self-reported behavior of teachers who participated in our PDP differed from those of teachers who did not. Next, we tried to identify different levels of data-mindedness, using latent class cluster analysis. Thereafter, the identified clusters of teachers were related to their baseline-measures on teacher attitudes and teaching practice, to changes therein, and to students' math achievement.

In chapter six, the main findings of this dissertation are recapitulated and discussed. In doing so, study limitations are addressed and recommendations for future research are provided.

The empirical studies presented in this dissertation related to the same PDP. Since we wanted the separate chapters to be readable in isolation, some overlap in terms of the background and content of the program was deliberately built in.